

the intervals between two stratifications the discharge is very likely carried as through the dark space at the negative electrode, while in the stratifications recombination of the decomposed atoms takes place.

An interesting law has been proved by Hittorf and E. Wiedemann in the case of the unstratified discharge. Hittorf shows that the fall of potential is the same in the positive part for the same tube whatever the current. This means that the energy dissipated is proportional to the current, and not to the square of the current as in a liquid. In the latter form the proposition had previously been proved by E. Wiedemann, who has shown that the total quantity of heat generated is proportional to the total quantity of electricity which has passed through the tube, whether in a few strong sparks or many weaker ones.

These experiments seem to point to the fact that once the original velocity of the particles at the regular pole has been reduced the velocity becomes independent of the strength of the current, that is to say, that in the positive part of the current greater intensity only means a greater number of particles taking place in the discharge.

The paper also contains spectroscopic evidence as to the state of dissociation in a vacuum tube, especially in the negative glow.

The question as to how the electricity passes from the electrode to the gas is not discussed, nor is it possible at present to decide, should the theory prove true, whether the polarity of the atoms in the molecule depends on the way in which these are combined, or whether that atom takes positive polarity which happens to be nearest the negative electrode as the molecule approaches it.

In conclusion some novel influence of the magnet on the negative glow is described, and it is shown that two different effects have to be clearly distinguished. The first is an effect of the magnet on the discharge when that discharge is established, and has been sufficiently well investigated. But the second effect depends on the question from what part of the negative electrode the discharge sets out. With respect to this question we meet with many contradictory and inaccurate statements. If at any place the magnet tends to throw the glow together the temperature will be raised, and owing to this fact the current will be strengthened, which again raises the temperature. It may thus happen that a slight cause can induce the current to pass almost exclusively from one part of the negative electrode. For a detailed description the reader is referred to the paper itself and the illustrations accompanying it.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

MR. ANDREW GRAY, M.A., assistant to Sir William Thomson in the Natural Philosophy department of the University of Glasgow, has been appointed to the Chair of Physics in North Wales University College. Dr. J. J. Dobbie, M.A., formerly "Clark" Fellow in Natural Science, has been elected to the Chair of Chemistry and Geology.

THE following is a list of prizes, scholarships, associateships, &c., awarded at the Normal School of Science and Royal School of Mines, South Kensington, June 1884:—First Year Scholarships: Albert G. Hadcock; Fred. Carrodus; William C. Rowden; Thomas Rose. Second Year Scholarships:—George Gibbens; Isaac T. Walls. "Edward Forbes" Medal and prize of books for biology, Thomas Johnson; "Murchison" Medal and prize of books for geology, Martin F. Woodward; "Tyndall" prize of books for physics, course I, Isaac T. Walls; "De la Beche" Medal for mining, Herbert W. Hughes; "Bessemer" Medal, with prize of books from Prof. Chandler Roberts for metallurgy, (1) Percy Bosworth-Smith, (2) William F. Grace; "Hodgkinson" prizes for chemistry, (1st, books, &c.) George T. Holloway; (2nd) Stephen J. Elliott and William P. Wynne. Associateships in Normal School of Science: chemistry, 1st class, George T. Holloway, William P. Wynne, and Elizabeth Healey; physics, 1st class, Benjamin Illingworth and Alfred Howard; biology, 2nd class, and geology 2nd class, Joseph Lomas. Associateships in Royal School of Mines: mining, 1st class, Herbert W. Hughes; mining, 2nd class, and metallurgy, 1st class, George H. Schröder; metallurgy, 1st class, Percy Bosworth-Smith, Alfred Sutton, Henry G. Graves, and Harry J. Chaney; metallurgy, 2nd class, William F. Fremersdorf and Erskine H. B. Stephenson.

SCIENTIFIC SERIALS

American Journal of Science, June.—On the tendency of rivers flowing to the north or to the south to encroach on their east or west banks respectively, by G. K. Gilbert. The author, after further study, here finally adopts the view that this tendency is sufficiently accounted for by terrestrial rotation.—Examination of Mr. Alfred R. Wallace's "Modification of the Physical Theory of Secular Changes of Climate," part ii., geological and palaeontological facts in relation to Mr. Wallace's modification of the theory, by Dr. James Croll.—Description of a new fossil marsupial from the Miocene deposits of Chalk Bluffs, Colorado, by W. B. Scott. This opossum, which the author names *Didelphys pygmaea*, is intermediate in size between the *D. murina* and *D. elegans* of South America. It establishes the fact that the small insectivorous opossums now characteristic of South America existed in Miocene times in North America, and is additional evidence that the latter continent is the source from which the former received the greater part of its fauna.—On a method of obtaining autographic records of the free vibrations of a tuning-fork, and on the autographic recording of beats (five illustrations), by Alfred G. Compton.—Notes on the volcanic rocks of the Great Basin, stretching for over 400 miles from the Sierra Nevada eastwards to the western base of the Wahsatch Range, by Arnold Hague and Joseph P. Iddings. In this region the association of andesites and trachytes, or trachytes and rhyolites, is unknown, and the authors infer that trachytes occupy a far more restricted position among volcanic rocks than has hitherto been generally supposed. They also consider that the geological independence of rhyolite and trachyte is now clearly established.—Transition from the copper-bearing series to the Potsdam in the St. Croix River Basin, Wisconsin, by L. C. Wooster.—On the expression of electrical resistance in terms of a velocity, by Francis E. Nipher.—Lateral astronomical refraction, by J. M. Schaeberle. The author proposes a simple remedy for the errors in astronomical observations arising from the assumption that all atmospheric layers of the same density over any given locality are parallel to the horizon.—Description of a remarkable variety of kaolinite from the National Belle Mine, Red Mountain, Ouray County, Colorado (three illustrations), by Richard C. Hills.—The influence of convection on glaciation, by Geo. F. Becker.—Description of a new *Dinichthys* (*D. minor*) from the Portage Group of Western New York (two illustrations), by Eugene K. S. Ringueberg. This specimen differs in several important respects from the two Ohio species *D. Herzeri* and *D. Terrelli*, Newb.—Mineralogical notes on allanite, apatite, and tysonite (two illustrations), by Edward S. Dana.

Revue d'Anthropologie, tome vii. fasc. 2, Paris, 1884.—On the weight of the cerebellum and the hemispheres according to Broca's mode of registration, by Dr. Philippe Rey, who has been commissioned by M. Topinard to continue the comparative tables and determinations which had already served as the basis of the memoir drawn up by the latter on the weight of the brain. Bicêtre, Saint-Antoine, La Pitié, and La Salpêtrière are the sources whence Dr. Rey has derived the requisite data for his work, and his conclusions must therefore be regarded as having more of a special than a general interest, since they are exclusively based on observations of the particular classes of persons confined in these institutions.—Study of primitive peoples, as the Kaffirs, and more especially the Zulus, by Élie Reclus. This paper presents little interest or novelty for English readers, as it consists almost entirely of extracts from English travellers and missionaries, and neither opens up new sources of information nor throws any novel light on the ethnography of the nations of whom it principally treats.—On the Kalmuks, by M. Deniker. In this second part of his memoir the author, after completing his description of the anatomical and physiological characters of the Kalmuk race, which he shows to be generally brachycephalic, supplies much important information regarding their present social and political condition under the influence of Russian domination. It would appear that the people have considerable mental capacity, various young Kalmuks having taken good places in the examinations of the University of Astrakan, and officiating creditably as medical practitioners, and as directors of the hospitals which the Russians are establishing for the benefit of the tribes. The change from a nomadic to a stationary life seems, however, to have been productive of decided injury, the census of 1869 showing a diminution of 22 per cent. in the population since 1862. According to the author, this diminution principally affects females, while this census presents, moreover, the singular

feature that male births are in excess of those of the opposite sex in the proportion of 139 to 100. It is conjectured, however, that this estimate may be incorrect, and due to the fact that women and female children are regarded as of little importance, on which account their numbers may not always be taken with exactitude. There would, on the other hand, appear to be no doubt of the fatal influences on the Mogul of the change from an easy, inactive, nomad life to that followed in a settled community, in which the struggle for existence has to be carried on under the pressure of continuous if not hard labour and fixed regulations.—On the so-called “xyphoid” angle, by M. Charpy. By this term the author designates the angle comprised between the edges of the xyphoid depression of the thorax, while his paper is devoted to the consideration of the extent to which its general inferiority in women may be due to the pressure exerted by corsets, and how far it depends on physiological causes and pathological conditions.

Bulletins de la Société d'Anthropologie de Paris, tome vii. fasc. 1, 1884.—This number, as is usual with the first of the series for the year, gives the various rules and reports of the Society, with a list of its members and associates, and the presentations made to it in the preceding year, together with the opening address of the president, M. Hamy. The remaining contents are:—A report, by M. de Mortillet, of the finds at Marcilly-sur-Eure, between Dreux and Évreux, where, in a red argillaceous loam, laid bare by a railway cutting, a cranium has been discovered of the Neanderthal type. Near the spot are deposits containing elephant, rhinoceros, and other bones, intermingled with numerous flint splinters.—On the Celtic cemetery of the island of Thinie at Portivy, Saint-Pierre-Quilerson, by M. Gaillard. In 14 of the 27 stone cists of various sizes which have escaped the destructive encroachments of the sea numerous remains have been found, some containing four bodies laid one above the other, and generally in inverse directions, and much bent. Some of the lower skeletons are admirably preserved, and all are remarkable for an extraordinary development of the occipital region and great flatness of the tibia. Flints and potsherds of the Dolmen age occur in large numbers.—On the Quaternary Equidae, by M. André Sanson, who bases his observations on the large collection of bones found by M. Chauvet in the Charente and Dordogne.—On the supposed flint atelier of Moulin-de-Vent, Charente-Inferieure, by M. Léon Rejou. According to M. Rejou, we have here not only the site of a prehistoric factory of ordinary flint implements, but the spot at which was manufactured a special form of these instruments, found here in considerable numbers, which he compares to our modern gimlet, and of which he has failed to discover any specimens either in the neighbouring Robenhausian deposits, or at any of the other French flint stations.—On the prehistoric flint beds at Chelles, by M. D'Acy. The most recent finds include a molar of *Elephas primigenius*, which thus confirm the hitherto contested view that this mammoth form must be included in the fauna of the Chelles beds, from which M. Gaudry had moreover already obtained three similar teeth.—On the so-called “Viens-Viens” of St. Domingo, by Dr. Dehoux, who believes that these, and other wild tribes of the Antilles, are the degraded representatives of mixed breeds, and not the descendants of primitive Indians.—On a placental anomaly, by Dr. E. Verrier, with illustrations of several other analogous abnormalities suggestive of the influence of atavism in the human subject.—On the races of the Philippine Islands, by Dr. Montano, with anthropometric tables. The author discovered traces both in ancient and recent skulls of the artificial cutting away of parts of the teeth practised in the archipelago, but he has not met in the living subject with evidence of the maxillary and other lesions, believed, according to various authorities, to result from this practice.—On a case of scaphocephalus observed in the living subject, by Dr. Delisle, with comparative tables.—On the Toltecs and their migrations, by M. Charnay.—On the Botocudos and Purys of the forests of Rio Janeiro, by Dr. P. Rey, with a vocabulary of their commonest words.—Contributions towards the ethnography of the Fuegians, by Dr. Hyades, member of the French Mission to Cape Horn. This paper is supplemented by a vocabulary and grammar drawn up by Mr. Bridges of the South American Missionary Society, whose papers on the manners and customs of the Fuegians from “A Voice for South America,” vol. xiii. 1866, is also given *in extenso* by the author.—On the use of iron in Egypt, by M. Soldi; and on the antiquity of the knowledge and use of this metal by the Egyptians, by M. Beauregard. In

the former of these papers the author attempts to show that stone implements were generally used in the preliminary labour of cutting blocks for statuary, and iron tools only for completing the final processes of sculpture. M. Beauregard, in his paper, deals, on the other hand, with the chronological bearings of the question, and considers at length the precise meaning of the various hieroglyphics supposed to indicate this metal.—On the rational and methodic process of deducing proportional means, more especially in reference to the general mortality of France, by Dr. Arthur Chervin. The author explains the methods employed by him for the categorical grouping of diseases as shown in his “Géographie médicale de la France.”

Sitzungsberichte der Naturforschenden Gesellschaft, Leipzig, 1883.—In a paper on the “Petrographic composition and structural relations of the Leipzig Graywacke,” Dr. Saur confirmed the previous conclusion of Geinitz, that the rocks cropping out in the diluvial of the Leipzig district belong to the North Saxon Graywacke system, which appears to be partly Cambrian, partly Lower Silurian.—A comprehensive memoir on the German slugs was read by Dr. Simroth, who divided this family into two groups: ARION, with three species (*hortensis*, *subfuscus*, and *empiricorum*); and LIMAX, with four subdivisions (*Limax* proper, *L. levis*, *L. agrestis*, and *Amalia*). In a second memoir the author dealt specially with the question of hermaphroditism and differentiation of sex in *Limax levis*.—A paper on the development of the tissues and histological system of the mammalians, by Prof. Rauber, recognises two fundamental types with possible transitional forms: (1) the type characterised by invagination of the embryoplastic pole of the germ cell (mouse, rat, guinea-pig); (2) the more general type marked by absence of invagination.—In an essay on the northern Silurian erratic boulders of the Leipzig district, Dr. Felix traces these rocks ultimately to South Sweden, Bornholm, Gotland, and especially Schonen.—A recent visit to the Brunswick Anatomical Museum suggests some interesting remarks to Dr. Hennig on the subject of malformations of the female pelvis in early life.—A paper by Dr. Rauber, on the influence of temperature, atmospheric temperature, and various elementary substances on the development of the animal ovum, aims especially at a more exact knowledge of the inner properties of the embryo. The subject is treated under two heads: (1) the power possessed by germs in various stages of resisting outward influences; (2) their plastic capacity, or power of adapting themselves by changes and modifications of all sorts to changed outward conditions. In a second paper the author reports the results of researches on the influence of increased or diminished proportions of saline solutions on Mollusks, Crustacea, Hydræ, and other aquatic fauna. His experiments point at the conclusion that the primeval oceanic waters must have always been saline.—In a memoir on the tin ores of the Eibenstock granitic system and their origin, Dr. Schröder infers that the tin ores resting on the tourmaline granites of Eibenstock have been exposed by the weathering of the associated rocks. The same conclusion is arrived at by Dr. F. Schall respecting a new variety of strontianite discovered at Wildenau, near Schwarzenberg, in the Erzgebirge.—Some remarks on the traces of glacial action on the porphyry rocks of Wildschütz near Eilenburg, Saxony, were submitted by Dr. Dalmer, who pointed out that the striae ran in two different directions, the older and normal from north-west to south-east, the more recent exceptionally between 60° N. and 80° E.—Dr. A. Sauer presented an exhaustive analysis of some specimens of the ashes from the Krakatoa eruption of last year. The material appeared to be a lava evidently of the augite-andesite family, closely related in structure to that of Turrialba in Costa Rica.—Dr. R. Sachsse reported on a new chlorophyll dye of a yellowish-brown colour, easily soluble in alcohol. The formula of this dye, which he names β -phæochlorophyll, is $C_{24}H_{32}N_3O_4$. In another paper he gave a chemical analysis of the feldspar present in the gabbro rocks of Rosswein, Saxony, which appeared to be closely allied in structure to true labradorite.

La Belgique horticole for October–December 1883 devotes a large portion of its space to a list of ornamental plants described or figured in Belgian or foreign journals, or in gardeners' catalogues, or exhibited in London, in 1882. The list comprises the large number of 251 species, of which 163 are Monocotyledons, and 105 belong to the single order of Orchidææ. The names are followed by very short descriptions.—There are also in the magazine a number of short notes of interest to floriculturists, the conclusion of an article

on the botanical discoveries of M. Roezl in America, and two fine coloured plates of *Cypripedium Spicerianum*, and *Aphelandra Margarita*.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 19.—"The Influence of Stress and Strain on the Physical Properties of Matter."¹ Part I. Moduli of Elasticity—*continued*. Relations between Moduli of Elasticity, Thermal Capacity, and other Physical Constants. By Herbert Tomlinson, B.A. Communicated by Prof. W. Grylls Adams, M.A., F.R.S.

The thermal capacity of each of the wires already used for the experiments on moduli of elasticity and electrical conductivity described in Parts I. and II. of this paper² was determined.

Every precaution was taken both with regard to the instruments themselves and the mode of using them to avoid error, and the formulæ given below may be received with great confidence.

Metal	Density at 20° C., density of water at 4° C. = 1	Formulæ for the number of thermal units required to raise the temperature of unit mass from 0° C. to t° C. Thermal capacity of water at 0° C. = 1.	Thermal capacity per unit mass at t° C.
Aluminium ...	2.731	$.20700t + .0001152t^2$	$.20700 + .0002304t$
Iron ...	7.750	$.10601t + .0000701t^2$	$.10601 + .0001402t$
German-silver.	8.632	$.09411t + .0000053t^2$	$.09411 + .0000106t$
Zinc ...	7.138	$.09009t + .0000374t^2$	$.09009 + .0000748t$
Copper ...	8.851	$.09008t + .0000324t^2$	$.09008 + .0000648t$
Silver ...	10.464	$.05466t + .0000218t^2$	$.05466 + .0000436t$
Tin ...	7.264	$.05231t + .0000361t^2$	$.05231 + .0000722t$
Platinum-silver	12.616	$.04726t + .0000138t^2$	$.04726 + .0000276t$
Platinum ...	21.309	$.03198t + .0000063t^2$	$.03198 + .0000125t$
Lead ...	11.193	$.02993t + .0000153t^2$	$.02993 + .0000306t$

It will be seen that the thermal capacity of all the metals examined increased with the temperature, a result which we find confirmed by the observations of other investigators.

The thermal capacities of the alloys platinum-silver and German-silver are, within the limits of error, exactly the same as those calculated from the proportions of their components. Thermal capacity is, therefore, a physical property which is not likely to be altered to any appreciable extent by small impurities, so that the results obtained by different experimenters agree very closely with each other.

It has been proved³ that if e be taken to denote "Young's Modulus," and a the mean distance between the centres of two adjacent molecules, $e \times a^7$ is in the case of most metals approximately a constant. From this it would follow that the law of force proved by Maxwell in his experiments on the viscosity of gases⁴ to exist between the molecules of a gas is approximately true for solids, accordingly the force between any two adjacent molecules of a solid is approximately as the fifth power of the distance between their centres. Now if we denote the atomic mass by A , the density by Δ , the thermal capacity per unit mass by C_m , and the thermal capacity per unit volume by C_v , we have the following relations:—

$$C_m \times A = \text{a constant};$$

$$C_v = \Delta \times C_m;$$

$$e \times a^7 = \text{a constant};$$

$$a \propto \left(\frac{A}{\Delta}\right)^{\frac{1}{5}}$$

From these relations we obtain—

$$\frac{e}{C_v^{\frac{1}{5}}} = \text{a constant};$$

or that the cube of "Young's Modulus" varies as the seventh power of the thermal capacity per unit volume. This relation was found to hold approximately not merely for the metals here

examined, but also in the case of a great many substances for which the values of C_v and e have been determined by other investigators.

Still more approximately it is believed that this relation would hold good if for "Young's Modulus" the bulk-modulus of elasticity were substituted. Denoting the bulk-modulus by e_v , it was found that, within the wide limits of error to which determinations of the value of the bulk-modulus are liable to be affected—

$$\frac{e_v}{C_v^{\frac{1}{5}}} = \text{a constant}.$$

Neither of the above relations can be true for all temperatures, inasmuch as, whilst the value of e_v diminishes with rise of temperature, that of C_v increases, but at ordinary temperatures it seems that the bulk-modulus of elasticity can be calculated from the thermal capacity per unit volume by the formula—

$$e_v = 2071 \times 10^6 C_v^{\frac{1}{5}}.$$

The thermal capacity per unit volume increases with the temperature, and the researches of Matthiessen, Fizeau, and others on the one hand, and of Kohlrausch on the other, have shown that there is a like increment in the thermal expansibility and torsionability¹ of metals. A careful comparison was made of the various increments above mentioned, and it is shown in the paper that whilst the ratio of increase per unit of expansibility with rise of temperature to corresponding value in the case of torsionability² is, within the limits of error of observation, unity, that in which thermal expansibility and thermal capacity are concerned is about two, so that the rate at which thermal expansibility increases with the temperature is about twice the rate at which thermal capacity increases. The rate of increase of both thermal expansibility and thermal capacity varies with the nature of the metal, being greatest for iron and least for platinum.

The so-called "real thermal capacity" of a solid may be found by dividing the thermal capacity of hydrogen per unit mass at constant volume, namely, 2.417, by the atomic mass; and this part of the capacity will be independent of the temperature. If the "real capacity" be subtracted from the total thermal capacity we obtain that part of the capacity which does vary with the temperature, and which has therefore in this paper been designated the "variable thermal capacity." The following table shows that the rate of increase per unit of thermal expansibility is at 0° C., and therefore at any temperature, equal to the increase per unit of the "variable capacity":—

Metal	Rate of increase per unit at 0° C. of "variable thermal capacity" = C	Rate of increase per unit at 0° C. of thermal expansibility = E	E/C
Iron ...	.00230	.00309	1.34
Tin ...	.00216	.00250	1.16
Aluminium ...	.00197	.00215	1.09
Lead ...	.00192	.00174	0.91
Copper ...	.00127	.00106	0.84
Zinc ...	.00157	.00170	1.09
Silver ...	.00135	.00155	1.15
Platinum ...	.00064	.00061	0.95

It is shown in the paper that the thermal capacity per unit mass is nearly two and a half times the "real capacity," so that only two-fifths of the whole thermal energy which we may impart to a mass of metal goes towards raising the temperature, the remaining three-fifths being expended in internal and external work. The external work is practically insensible in ordinary cases. Of the internal work, that expended against bulk-elasticity amounts in the limiting cases from 1/1,000th to 1/10,000th of the whole, and, though greater than the external work, is almost insensible; moreover, there seems to be no relationship whatever between the whole thermal capacity per unit volume and the work done against bulk-elasticity.

Raoul Pictet has concluded³ that the amplitude of the oscillation of molecules around their positions of equilibrium may be taken as corresponding to temperature, and in the case of several metals has shown that

$$T \times \beta \times \alpha = \text{a constant},$$

¹ The inverse of "simple rigidity."

² Iron and copper are the only two metals for which the increase of torsionability with rise of temperature has been examined.

³ NATURE, 1879, p. 356.

¹ The original title of the paper has been altered to the above, as being more exact in expression.

² Phil. Trans. part i., 1883, p. 1.

³ Loc. cit. p. 32.

⁴ Phil. Trans. 1866, vol. cxxvi, part i.